Kelly Heber[1]

Ecosystem Services and Community Based Coral Reef Management Institutions in Post Blast-fishing Indonesia

Abstract
Depending upon the institutional framework, coral reef ecosystems and local economic development can be synergistic. When managed properly through local institutions, coral reef systems can deliver ecosystem services that create livelihoods and increase local prosperity in dependent communities. This study compares two community-based reef management institutions. One is located in a community with a reef struggling to recover from destructive fishing, the other in a community that has experienced a remarkable recovery. Using mixed methods, long-form interviews, and surveys of reef tourism stakeholders, this uses institutional characteristics to predict reef quality. Certain institutional components hypothesized to predict reef quality did not; these include universal membership requirements for reef stakeholders, stakeholder familiarity with leadership and hierarchies, and transparent decision-making and implementation of management policy. This means that one size fits all prescriptions for local reef management institutions should be viewed with caution. Instead, the success of management institutions may depend upon both the path toward economic development, access to technology that facilitates coral recovery, and communication of conservation strategies to tourist visitors.

Key Words
Ecosystem Services
Coral Reefs
Community Based Management
Co-Management
Resilience
Institutions
Marine Protected Areas

Abbreviations
TEs: Tourism Elites
MPAs: Marine Protected Areas

[1] Massachusetts Institute of Technology, Environmental Policy and Planning 77 Massachusetts Ave. Cambridge, MA 02139 & Woods Hole Marine Policy Center MS #41 Woods Hole Oceanographic Inst. Woods Hole, MA 02543
Email: k_heber1@mit.edu

1. Introduction

Southeast Asia is home to the world's largest network of coral reefs. With reef ecosystem service values estimated at $2.3 billion U.S. annually, regional governments are trying to improve management (Tun et al. 2008). One method involves designing and implementing management institutions with interdisciplinary aims, including both ecological and socio-economic management goals. Reef management institutions are the set of rules, labor, financing, technologies, and sanctions that determine rate and extent of resource use (Renard 1991, White et al. 1994). Over the past decade, Southeast Asian nations have been adopting reef management institutions from national to local scales that consider stakeholder income, social norms, values, and culture (Tun et al. 2008).

The primary goal for policy-makers and communities designing management institutions is healthy ecosystem outcomes that provide a level of *ecosystem services* that contribute to socio-economic wellbeing (Hughes et al. 2003, MEA 2003). Reef ecosystem services could include: fisheries production, reef tourism, buffering from extreme weather and storm surge, erosion protection, and cultural and aesthetic values (Costanza et al. 1997, Moberg and Folke 1999, Peterson and Lubchenco 1997). The Global Coral Reef Monitoring Network estimates that 120 million Southeast Asians depend directly on reefs for their sustenance and economic needs, with significant proportions of the population completely dependent on reefs for all aspects of their livelihoods (Wilkinson 2008). Beyond those who make their living off local reefs, 60% of Southeast Asia's population lives on or near the coast, thus benefitting from reef ecosystem service delivery (Salvat 1992).

Experts argue that there is still a profound need to improve reef management as it has failed to meet its primary goal (Bellwood et al. 2004). Southeast Asian reef ecosystems continue to decline (Hughes et al. 2003, Brown 1997, Richmond 1993). One noteworthy option is to shift the focus of management institutions to reef *resilience*, or its ability to recover from man-made or natural disturbances (Bellwood et al. 2004, Berkes et al 2000, Berkes et al. 2003, Holling 1973). Institutions aimed at reversing degradation would enhance resilience as well as reef capacity to deliver ecosystem services to stakeholders (Cesar 2002, Costanza et al. 1997, Moberg and Folke 1999).

This study contends that there exist specific institutional characteristics that facilitate ecological reef recovery and act synergistically to strengthen reef-based livelihoods, specifically reef tourism livelihoods. Scholars have demonstrated empirical links between institutions, ecological resilience and socio-economic stability of dependent communities (Bellwood et al. 2004, Myers et al. 2000, Nystrom et al. 2000, Pauly 1995, Roberts et al. 2002). Thus local management institutions are critical to enhancing ecosystem service delivery along with resilience of reef communities (Kittinger 2013, Mascia 2001).

This paper analyzes the relationships between ecological reef outcomes that result from management institutions designed by reef communities. This study compares two Indonesian community-based coral reef management institutions,

examining the key differences in institutional design, and linking the differences to reef health outcomes. Case selection for the comparative study design controlled for several possible confounding variables to institutional design. Beginning with village exposure to destructive fishing, or the use of dynamite and cyanide methods that negatively impacted Southeast Asian reefs since the 1950s and later outlawed in 1985 (Badruddin and Gillet 1996, Pet-Soede et al. 1999). Both case villages saw decades of dynamite and cyanide fishing at comparable levels given their geographic proximity. Secondly, the timing of reef management efforts coincides, since the communities made simultaneous efforts to design reef management institutions following national-level conservation policy that outlawed destructive fishing over two decades ago. Finally, both communities are seeing evidence of either ecological improvement, or of institutional and managerial improvement around reef conservation.

The main objective of this study is to examine the relationship between reef ecosystem outcomes that result from distinct institutional characteristics of local reef management regimes. The seven institutional building blocks examined here include: the presence of clear membership requirements, internal hierarchies, day-to-day involvement of elected leaders in management practice, transparency and knowledge of the leadership and their responsibilities to the institution, whether the leadership helps build capacity in the organization, whether all members can be elected as leaders, and whether the institution is autonomous or under the influence of elites.

This study uses a mixed methods approach to develop 1) a quantitative model to highlight significant differences in the above-listed institutional variables in a village with high quality reefs compared to a village with low quality reefs and 2) in-depth accounts from stakeholders from long form interviews that explain significant institutional differences. This study uses quasi-experimental design, where the outcome (reef health) is viewed as a dependent variable, with the aforementioned theoretically important independent variables examined across case sites, controlling for confounding factors. Quasi-experimental designs are considered best practices for research on community-based management of natural resources (Thomas et al. 2014). They allow for assessment of environmental outcomes after decades of local level management targeted at eliminating destructive fishing, without the need for a multi decade study.

To operationalize the building blocks of reef management institutions, this study draws on the theoretical work on institutions for managing common pool resources, primarily on Ostrom's Institutional Analysis and Development Framework (IAD) (2009). IAD argues there are strong links between institutional designs and the health of the managed resource, based on hundreds of empirical studies (Ostrom 2009, Wamukota et al 2012). IAD also theorizes the universal building blocks of the common pool resource management institution, and uses these components to hypothesize subsequent ecosystem response. These key institutional building blocks include: the rules for entry and exit into management organizations (management boundaries), rules of access to the resource, sanctions for when rules are breached, characteristics of the biophysical and ecological system, and details on the community such as local values, behavior, and culture (Agrawal 2001, Becker and Ostrom 1995, Ostrom 1990, Ostrom 2005).

Institutions have also been theorized in the *complex socio-ecological systems* literature, which hypothesizes links between human systems (institutions and economies) and ecosystems. Socio-ecological systems are characterized by dynamic, non-linear relationships where sudden shifts into undesired states can occur across systems (Armitage et al. 2007, Berkes et al. 2003, Berkes and Folke 1998, Ingold 2000). The socio-ecological systems framework hypothesizes several attributes of successfully designed management institutions. *Successful* institutions can be defined in two distinct ways. These include 1) *socioeconomic successes* where stakeholders enhance their ability to collaboratively interact for conservation purposes (Christie 2004) or 2) *ecological success* where healthy condition of the reef and the maintenance of key ecological parameters occur (Hughes et al. 2003, McClanahan et al. 2006). Sometimes, only one type of success is present in co-managed systems (Wamukota et al. 2012, Christie 2004, Brooks et al. 2006). In other words, specific characteristics of management institutions may not necessarily cause healthier reef ecosystems, but they have potential to enhance the way stakeholders build relationships and collaborate towards sustainable stewardship of reefs (Cinner et al. 2012). Some studies have pointed out that privileging one definition of success over the other ignores important considerations of the socio-ecological system (McClanahan et al. 2009).

Successful management institutions, using either definition of success, tend to have the following design characteristics according to socio-ecological systems thinking: *participatory design* that is inclusive of all stakeholders groups (Berkes et al. 1991, Pinkerton 1994), *flexible and adaptive structure* that incorporates new learning into management decision-making (Berkes 2007, Plummer and Fitzgibbon 2004), and *development origins within the community* so that it is specially designed for conditions in a specific place (Olsson et al. 2004). Co-managed institutions fit these design characteristics for successful management institutions.

A community-based management system is *co-managed* when there is a form of power sharing between national government and communities (Berkes 2007, Armitage et al 2007). The field sites in this study are co-managed reef systems. This study synthesizes definitions of co-management from similar studies to define co-management as an institutional framework with: participation by local and diverse stakeholders; integration of reef management choices with the broader socio-economic needs of a community; empowerment of the community to act as resource managers; and employing local environmental perceptions to make management decisions (Cinner et al. 2009 (b), Christie 2007, Christie and White 1997, Kittinger 2013, Wells et al. 2006, White et al. 1994, White et al. 1994).

Co-managed institutions are the focus in this study for several reasons. First, the literature has demonstrated links between co-managed reefs and sustainable coral reef outcomes specifically when key institutional building blocks are in place (Agrawal 2001, Cinner et al. 2009 (b), Cinner et al. 2012, Pomeroy 1995, Wamukota et al. 2012). Co-managed institutions prevent degradation that would lessen the ability of ecosystem services to benefit communities (Grilo 2011). Other studies also demonstrate links between co-managed ecosystems and improved livelihoods, improved compliance with rules managing access, and in some cases, larger target fish species in terms of biomass

(Cinner et al. 2012). Therefore, improving institutional capacity is an "essential component of sustaining broader coral reef seascapes" (Cinner et al. 2009 (a) p. 209). Co-managed ecosystems improve efficiency of resource use and *good governance*, or transparency and legitimacy in management policy-making (Jentoft et al. 1998).

Some criticism in the scholarship on co-management includes how systematic, empirical work linking institutions to biophysical outcomes is lacking (Cinner et al. 2012, Wamukota et al. 2012, Stevenson and Tissot 2014). Empirical work that includes both quantitative and qualitative data drawing on the experiences of stakeholder groups is also scarce. Lastly, that the scholarship on co-managed reefs is an underdeveloped causal link between institutions and reef ecosystem outcomes (Stevenson and Tissot 2014). Despite these criticisms, there is evidence that under certain design conditions co-management is capable of meeting various conservation and economic development goals (Grilo 2011, Christie and White 2007, Cinner et al. 2005, Cinner and Huchery 2014). In addition, institutional analysis is a critical way of addressing a lingering criticism of co-managed institutions relevant to this study. This involves the problematic use of the term *community*, where some argue it is a misleading term that erroneously suggests communities are homogenous entities (Broisus et al 1998, Berkes 2011). The term masks internal complexities, such as socio-economic differences between well-connected elites compared to low-income community members. Institutional analysis is a way to break down complex socio-economic divisions, and instead look at rule making patterns and enforcement mechanisms to sidestep the problem of theorizing the community as a homogenous entity (Ostrom 1990).

This study builds on the findings of previous work detailing co-managed reef institutions and their relationships to ecosystem health (Cinner et al. 2012, Cinner et al. 2009 (b), Wamukota et al. 2012, Stevenson and Tissot 2014). These have focused on several attributes of co-managed reef institutions that include: institutional rules governing access, the boundaries between reef resource users and non-users, the decision-making processes of stakeholders, and various sanctions employed for enforcement. The novel contributions of this study include significant findings on the relationships between reef health and institutional components that include well-defined leadership roles, internal institutional hierarchies, and day-to-day involvement of reef management leaders. In addition to quantitative findings this study seeks to contribute qualitative details on institutions that are often inadequately reported (Wamukota et al. 2012, Ostrom 2007, Agrawal 2001). This study also deals with the often-mentioned problem of multiple possible definitions of successful management. Successful management can make for healthy ecosystem outcomes, collaborative social institutions, or a combination of both. By using biophysical reef data, but triangulating it with social perceptions and attitudes on reef-based tourism, this study contends with the multiple definitions of successful reef management.

2. Study Sites

Indonesia is the field site for this study because its political system allows for co-managed institutional frameworks in its villages. There are strict statutory protections for reefs at the highest levels of government, yet the real sources of reef governance are

community-based management regimes that vary immensely from village to village (Christie et al. 2004, Crawford et al. 2004, Halpern 2003, Kittinger 2013, Ross and Wall 1999). Co-management requires a substantial devolution of power to the local scale. In Indonesia's case, what was once a highly centralized political system, most notably in the Suharto dictatorship era, entered a period of devolution policy around resource management beginning in 1998, known as the *Reformasi.* It saw communities and local governments, such as regency and provincial governments, gain management authority over the resources they depend on for economic livelihoods (Clifton 2003). Devolution is also evident in Indonesian coastal laws (such as Law No. 22) that mandate local-level management over marine resources from the shoreline to twelve nautical miles from shore; this includes nearshore reefs and their fisheries.

Beyond devolution-oriented public policy, several factors make the enforcement of Indonesian national-level reef conservation laws impractical at any scale other than local, these include: a persistent lack of funds for implementation, the lack of capacity to enforce regulations along its lengthy coast, and corruption at all levels of governance (Christie and White 2007, Erdmann 2001, Mous et al, 2000, Pet-Soede and Erdmann 1998, Pet-Soede et al 1999, Satria et al. 2006). Therefore, a major determinate of Indonesia's ability to co-manage its resources depends on communities' abilities to design institutions at the local level (Pomeroy 1995). Despite its reform efforts, Indonesian reefs continue to decline overall (Tun et al. 2008). Data is somewhat patchy, yet most of Indonesia's reefs are now classified as fair, poor, or very poor quality (COREMAP).

The two cases analyzed for this study, Lovina and Pemuteran are located within the Buleleng Regency on the northern coastal stretch of Bali, Indonesia. Both villages attract thousands of tourists every year spending tens of millions of dollars to visit area reefs (see maps in Figures 1 and 2). The case communities have reef tourism economies based entirely on the capacity of reef to deliver recreation and tourism ecosystem services. The recreational and tourism value of Indonesian reef ecosystem services is a significant amount of its overall economic activity (Cesar 2002). Lovina and Pemuteran both have village level institutions for reef management. Institutions are formed to manage reefs as healthy ecosystems, but they also act as a positive feedback mechanism for social-economic wellbeing by encouraging collaborative decision-making and relationships among reef stakeholders. There exists a potential synergistic effect between enhanced ecosystem service delivery, strong community-based management institutions, local agency, and local incomes.

Certain variables of the case sites were controlled for, these include: 1) both villages actively manage nearshore fringe reefs using co-management regimes, 2) both communities have suffered comparable levels of reef degradation both in terms of intensity and timespans, and have been subjected to the same conservation strategies from local and national government, 3) both villages banned commercial and recreational fishing on nearshore reefs where tourists are brought to snorkel or dive, 4) protected reefs are visible from the village shoreline, an attribute that has been shown to increase compliance with conservation measures (McClanahan 2006), 5) the villages rely primarily on reef-based tourism for local livelihoods. The key difference is the

ecological outcomes of reefs as well as the specific makeup of reef management institutions. See table 1 for a comparative summary of both field sites.

Table 1: Comparisons between case sites

	Lovina	Pemuteran
Population	~9,000	~8000
Size	4 km	2 km
Per Capita Income (Source: BPS 2013)	643.38	643.38
Overall Reef Quality	Poor to fair	Fair to Good
Tourism begins as a significant level	1988-1989	1990-1991
Tourism Purpose	Marine Mammal watching, Diving, Snorkeling, Beaches	Diving, Snorkeling, Beaches
Brief description of reef based tourism and economic development	Lovina depends dolphin watching and reef tourism that bring around 30,000 tourists annually. 60% of tourists come from the Europe and the U.S. The tourism economy is worth $10 million annually into Lovina's economy.	Pemuteran was one of Bali's poorest villages up until 1990. Since 1989, its land prices increased by 400%. Currently, its economy depends on diving and its rapidly spreading reputation as a world-class, award-winning destination for reef tourism.
Declaration of protected areas of local reef where fishing is prohibited, marked by at least one mooring buoy	1998	1995
Location of healthy reefs	Anturan village nearshore reef, five other villages have reefs too degraded to bring tourists to visit	all reefs visible from the shores of Pemuteran are healthy

Both case sites fall within a future nationally mandated marine protected network currently under review by the Indonesian government and international environmental organizations (Nurhayati 2010). Currently, both communities impose strict no-take rules on their reefs, making them effective yet small marine protected areas. Marine protected areas (MPAs) are recognized globally as the one of the best strategies for managing coral reefs (Dodge et al. 2008). MPAs create designated areas where harvesting reef species is limited or forbidden, allowing for fish stocks and coral cover to recover from damage (National Research Council 2000). Increasingly, international environmental organizations, local grassroots groups, and governments are advocating that reef communities in developing countries plan, develop, and manage their own marine protected areas (Bellwood et al. 2004, Bohnsack 2003, Halpern and Warner 2002). Studies show that numbers of MPAs are on the rise in Indonesia, where coral reefs are included in 38 of Indonesia's 114 registered MPAs, 12 of there were newly listed in the last decade (Reef Base 2007). Despite this positive trend, less than 3% of Indonesia's reefs are rated as "effectively managed" underscoring the need for improved management frameworks therein (Reef Base 2007).

Both Pemuteran and Lovina were primarily fishing villages before their tourism booms in the late 1980s and early 1990s. They transitioned into reef based tourism villages in the 1990s. Currently, there is no large or small-scale commercial or recreational fishing allowed on the nearshore reefs, through random instances of poaching do occur. Village stakeholder institutions have monitoring and enforcement protocols to prevent this. All locally owned fishing vessels are required to travel several miles off shore when fishing, often brining them into Javanese waters. Thus, the fishing sector and its management institutions do not have conflicts of interest with the local

MPA. In both villages, graduated sanctions are in place to prevent fishing and to deter breaches of rules; sanctions have been shown to increase compliance (Cinner et al 2012). Since reef reserve areas are visible from the village beach, rule breaking seldom occurs. Line and pole fishing by native villagers is permitted for family consumption only, and was observed in both in Lovina and in Pemuteran. Studies have shown that subsistence based line and pole fishing does not negatively affect ecosystem health when measured in targeted species diversity and biomass (McClanahan et al. 2006).

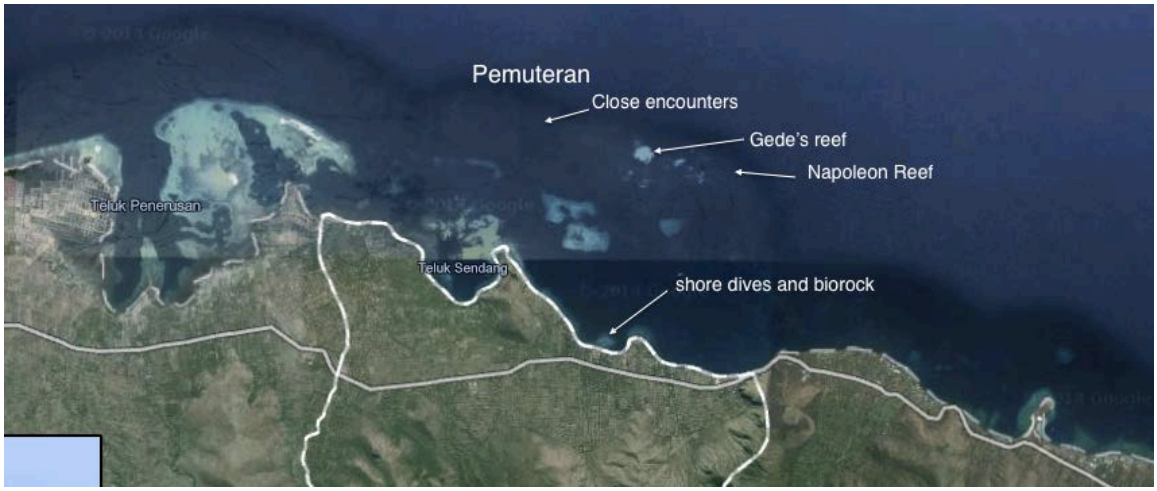
Both communities have similar timelines of reef destruction and recovery due to similar anthropogenic drivers in their development histories. Destructive fishing methods such as cyanide poisoning and dynamiting were commonly used in both Lovina and Pemuteran from the 1950s up to the 1990s, and it has continued in lesser and varying degrees throughout Indonesia into the 2000s (Erdman 2001). In 1985, *Indonesian Fisheries Law Number 9* prohibited of the use of such methods (Badruddin and Gillet 1996, Pet-Soede et al. 1999). Aside from an uptick in illegal dynamiting in the region during the Asian financial crisis of 1998, illegal destructive fishing has declined substantially. Since the 1980s and 1990s, there has been the greatest decline in users of destructive fishing methods who target their home village reefs. Instead, poachers that tend to be from distant locations, including the Philippines and Thailand, are responsible for destructive fishing methods today. Spare a few isolated incidents; the blasting and cyanide fishing have virtually ceased in these case sites thanks to severe legal penalties, increased local awareness, enforcement, and graduated sanctions. The case sites experienced similar levels of blast fishing destruction early in their development history since they are nearby to one another, approximately 45 kilometers apart. They also implemented no-take rules on local reefs within three years of one another. Thus, the baseline of damages across sites was comparable when management institutions were enacted.

Figure 1: Lovina

Lovina is actually the name for several adjacent villages that make most of their revenue from dolphin watching and reef snorkel tours. This study administered stakeholder surveys in the four villages depicted in Figure 1. Lovina's villages have reefs that are visible in near shore waters, with the healthiest reef just off Anturan village. This reef is open to all of Lovina's reef tourism workers to bring boats of tourists for snorkeling trips, regardless of their home village. In addition to reef tourism, Lovina depends on its well-known dolphin watching tours that bring around 30,000 tourists annually, 60% of them from the West, to observe dwarf spinner dolphins (*Stenella longirostris roseiventris*)(Mustika 2011). Dwarf spinners congregate in Lovina to forage its near shore reef fisheries. Tourists inject almost $10 million annually into Lovina's economy, with nearly half spent on the dolphin watching tours directly. Lovina also depends on snorkel and dive based tourism to a lesser extent, because its reefs are still recovering from heavy damage.

Stakeholders in Lovina around reef tourism include: 1) the reef and dolphin tourism institutions. These village level reef management institutions manage access to dolphin and reef snorkel tours, their Balinese names include *Bhakti Dharma Segara* and *Kharya Bhakti Samudra.* All stakeholders involved in reef tourism, such as boat captains, guides, and engine repairmen are required to join these organizations. 2) Various tourism workers such as hotel owners, restaurant owners, recreational equipment rental shop owners, and their employees. 3) Village level leaders, such as the head of the village, are involved to a small degree in the decision making of the reef management institutions. Their approval over certain management policies often involves payment.

Figure 2: Pemuteran



Pemuteran is a single village with a large area of local reefs. It generates most of its revenue through dive tourism, with its most popular reefs identified in Figure 2. Pemuteran was one of Bali's poorest villages up until 1990. Since 1989, its land prices have soared to 400 times what they once were (Savitri 2001). Respondents suggested

that this figure is many times higher in 2013. Currently, its economy is expanding as the village gains reputation for being a world-class, award-winning destination for reef tourism. Besides its natural reefs, it has several *BioRock* formations, where mineral accretion technology is used to enhance coral growth through electric shock. These formations are free for tourists to visit, and are within a short swim from the shoreline. Facilities for environmental education, such as libraries, and information centers line the shore. Tourists are encouraged to learn about how the community acts as a reef steward.

Stakeholders in Pemuteran include 1) The *Pecelan Laut*: the religious inspired sea police who patrol the reef on Saturdays and Sundays for poachers. Hierarchically organized, members have different management responsibilities at different levels, and membership is highly prestigious in the community. 2) BioRock: an international network of coral restoration projects that grow coral at expedited rates using electrical charge. BioRock Pemuteran has won awards from various multilateral aid entities for its nursery built in 2000. It has a visitor's center with a library on the main beach. 3) The informal network of local hotels: these owners of larger hotels have made investments in reef management organizations, spearheaded their own organizational projects, sponsored and organized cleanup, and coral restoration. They are well known in the community. 4) Village-based management: This includes traditional village leadership (i.e. the head of the village plus an elected and appointed staff). 5) Reef Gardeners, Turtle Project, and other charities: charities attached to local hotels, primarily responsible for invasive species removal and biological monitoring. 6) Various tourism workers, such as dive shop technicians, operators, boat captains, tank fillers, hotel owners, restaurant owners, and tour package sale point operators.

3. Methods

This study uses a mixed methods approach, relying on qualitative and quantitative analysis (Creswell and Clark 2007). Data collection took place in two phases. Phase one began with 73 long form open-ended stakeholder interviews in the summer of 2013 from July to August. These interviews were based on an initial literature review and were used to elicit further *grounded theory* on the characteristics of reef management institutions (Glaser and Strauss 2009, Strauss and Corbin 1997). These theoretical building blocks of institutions were then used as comparison points in a quasi-experiment. This type of research design measures the effects (reef health) after a *treatment*. In this case there are two experimental treatments, they include 1) conservation policy outlawing of blast fishing in the 1980s and 2) collaborative management institutions at the local scale implementing this policy. Quasi-experiments are posited as the best methods for assessing the effects of co-managed institutions on natural resource outcomes (Thomas and Koontz 2011).

Respondents were sampled in a snowball method, where key informants (such as local leaders) were asked to recommend other knowledgeable stakeholders to speak with. Interviews ranged from one to four hours, and included four focus groups of local stakeholders who earn their livelihood from reef tourism. Of the stakeholders surveyed, 38% were boat captains on vessels they own and operate, 46% work in the dive

industry, 8% work in some capacity as reef management organization leadership, 3% work in boat maintenance, and the remaining respondents work in a general capacity in reef-based tourism.

Following the interviews, phase two took place from August to September 2013 where a survey questionnaire was developed that examined six distinct indicators of reef management institutions that include: the presence of clear membership requirements, internal hierarchies, day-to-day involvement of elected leaders in the management institution, transparency and knowledge of the leadership and their responsibilities to the institution, whether the leadership helps build capacity in the organization, whether all members can be elected as leaders, and whether the institution is autonomous or under the influence of elites. These six indicators were drawn from the interview phase and from theory on co-management institutions.

Structured surveys were administered verbally to 113 respondents who were not asked to fill in questionnaires. All respondents were able to read them while the author recorded their responses. The author conducted these surveys alone, with nearly 80% done in English and 20% done in Indonesian upon request. No translator was required, spoken English is widespread in these two villages thanks to tourism. Stakeholders in both villages were surveyed randomly, in areas where they congregated socially after they finished a day of work bringing tourists to the reefs. This random method generated a number one to five (*n*), and surveyed the *n*th person sitting along the benches and tables in these locations.

A copy of the short questionnaire is listed in Table 2. For each question, also included is the name of that variable used in the model outlined below, as well as the hypothesized relationship the variable has to reef health.

Table 2: Institutional indicators that predict reef quality

Survey Question	Variable Name	Hypothesized Relationship
Are all reef stakeholders required to join the reef management institution?	***boundary***	When all stakeholders involved in reef tourism are required to join, health reefs are predicted.
Is there a defined hierarchy in the organization?	***hierarch***	Well-defined hierarchies predict healthier reefs because management responsibilities are more clearly defined.
Are the leaders of the reef management organization involved with the day-to-day operations of reef management? (Clarifying question: do your leaders do patrols, remove crown of thorns, or do ecological surveys?)	***mgmt***	When leaders are involved in day-to-day management tasks such as monitoring, there will be healthier reefs. This is because stakeholders can learn best practices from their leaders.
Do you know who is leading the efforts to manage local reefs? (Clarifying question: Would everyone say the same name if asked?)	***member_aware***	When institution leaders are well known by members, the result is healthier reefs. This is because management responsibilities are more clearly defined.

Is the reef management organization transparent when it makes decisions?	***transpar***	When stakeholders know how decisions get made, and why certain decisions get implemented, there are healthier reefs. This is because there is greater transparency and thus greater buy-in.
Do leaders of reef management organizations help educate members and improve reef management strategies?	***leader_educ***	When leaders take an active role in helping train and educate institution members, there are healthy reefs.
Can any member be elected to the reef management organization leadership?	***oppor_elect***	When there is shared responsibility such as the opportunity for any member to stand for election, there will be healthier reefs.
Do wealthy or people dictate what happens to the reef even if you vote?	***auton1***	When stakeholders view themselves as autonomous managers of the reef, this leads to higher reef quality.
Do hotel owners make decisions or is it the organization's members?	***auton 2***	When wealthier stakeholders have equal authority over the reef decisions to other reef stakeholders, there are healthier reefs, because more legitimacy is perceived and more buy in occurs.

4.0 Analysis

Using the independent variables in Table 1, a model was developed after several combinations of predictor variables were tried. This model predicts a categorical output for reef quality ***Q***, expressed as a probability ranging from "poor" to "good" reef status[2], as a function of 1) ***boundary***, the requirement that all reef tourism operators join the institution, 2) ***hierarch***, internal hierarchies, 3) ***mgmt***, day-to-day involvement of elected leaders in the management institution, 4) ***transpar***, transparency and knowledge of the leadership and their responsibilities to the institution, 5) ***leader_educ***, whether the leadership helps build capacity in the organization, 6) ***oppor_elect***, whether all members can be elected as leaders, 7) ***member_aware***, where institution members know their leaders, and 8) ***auton1*** and ***auton2,*** two measurements over whether the institution is autonomous.

The model is conceptualized as follows:

$$E(Q) = \alpha + \beta_1 boundary + \beta_2\, hierarch + \beta_3\, mgmt + \beta_4\, transpar + \beta_5\, leadereduc + \beta_6\, oppor_{elect} + \beta_8 memberaware + \beta_7 auton1 + \beta_9 auton2 + \varepsilon$$

[2] Based on percent coral cover from UNEP 2005

Logistic regression, an increasingly prevalent analytic tool in ecosystem management scenarios, was used primarily because of the convenience in terms of time, personnel, and financial constraints available for data collection. Its limitations have been discussed at length (Cleary and Angel 1984, Pearce and Ferrier 2000). These include the requirement that outputs are categorical, and also that distortions can be possible when the independent variables are highly correlated with one another. Very large sample sizes are typically required to overcome this limitation, but given the time and financial constraints, 113 respondents were surveyed. Given such limitations, qualitative data is also used to address model outputs and shape conclusions with additional context.

4.1 Triangulation of Dependent Variable

The categorical dependent variable *Reef Quality* is derived from a UNEP study that measured percent cover of living reef building corals in these two case sites (UNEP 2005). Reef ecological quality can be defined as maintaining key ecosystem parameters such as coral cover (McClanahan et al. 2006). However, there has been some evidence that percent cover may not respond to management efforts in the way that other biophysical indicators of health may (McClanahan et al. 2006). Percentage hard cover coral is a useful indicator of coral health for this study however, because it is a relatively inexpensive way to gauge whether large-scale, impactful damages are still occurring to the system, such as dynamiting. Coral reef field survey protocols suggest that percent cover is a viable economic and ecological indicator of reef health for rapid assessment and monitoring needs (Hill and Wilkinson 2004). This is especially true in reef tourism scenarios, where visitors expect to see living corals. Large amounts of living coral cover also help reefs deliver maximum amount of ecosystem services to communities who depend on them for recreation and tourism. Despite criticism, the same critical study argues that ecological indicators can be used as long as differences are present when comparing across different management institutions (McClanahan et al. 2006). Because there is a difference in percent coral cover between Lovina and Pemuteran, with limitations noted, it is used here as the indicator for reef health.

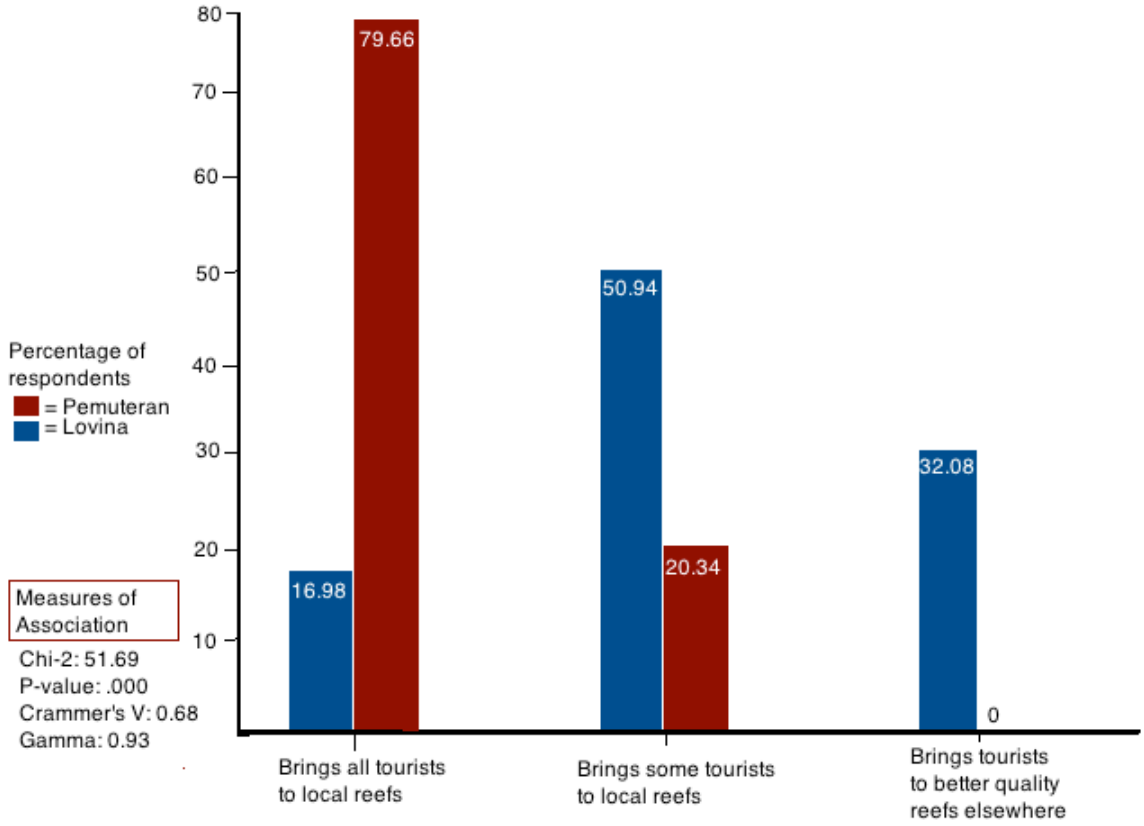
Given the limitations of hard cover, and in order to ensure that both socioeconomic and biophysical definitions of successful reef management were used, interview and survey questions were used to triangulate the UNEP reef health data to determine stakeholder perceptions on village reefs. Interviews assessed whether stakeholders brought visitors to nearby reefs. If they did not and instead brought them further afield, follow-up questions were asked about why they did not bring tourists to reefs. Nearly all of the respondents said it was because the local reefs were not as nice for tourists as other options nearby. Table 3 shows the results, which match the categorical UNEP data on coral reef health in the two communities in this study. Figure 3 demonstrates further that the categorical UNEP measurements of coral cover are reliable representations of reef ecosystem health, and it shows how stakeholders in Pemuteran bring nearly 80% of all tourists to their local reefs, versus just 32% in Lovina. From these numbers, conclusions on the substantial differences in recreation and

tourism based ecosystem services that each reef system offers their communities can be drawn.

Table 3: Stakeholder perceptions on ecosystem health

Survey Question	Variable name	Pemuteran	Lovina
Are the reefs healthy?	***Enviro_percep***	92.45% Yes	28.81% Yes
		7.55% No or I don't know	71.19% No or I don't know

Figure 3: Perceptions of stakeholders: "Do you bring your tourists to the village reef or a reef nearby instead?"



3.0 Results: Significant Differences in Reef Management Institutional Design

Table 4 displays the statistically significant institutional variables from the final model. Significant variables that serve as predictors of reef quality include 1) ***boundary***, if all reef tourism practitioners are required to join, 2) ***mgmt***, day-to-day involvement of elected leaders in the management institution, 3) ***transpar***, transparency and knowledge of the leadership and their responsibilities to the institution, 4) ***oppor_elect***, whether all members can be elected as leaders, and 5) ***auton1,*** institutional autonomy.

Table 4: Logistic Regression Results

Variable	Estimated Coefficient	S.E.	z-score	Marginal Effects
boundary	-2.50	1.32	-1.89**	-0.33
hierarch	-1.94	1.30	-1.49	-0.25
mgmt	-6.06	2.35	-2.58***	-0.74
member_aware	2.25	1.96	1.15	0.50
transpar	-3.67	1.36	-2.68***	-0.55
oppor_elect	-2.04	1.27	-1.61*	-0.33
auton1	0.54	1.37	0.40	0.10
auton2	2.92	1.41	2.07**	0.53
Constant	7.56	2.91	2.59***	n/a

Pseudo R-squared: 0.84
Likelihood Ratio Test Chi-2: 129.94 (6 *df* , p-value 0.000)
Total Observations: N=112

_____

*Significant at =0.1
**Significant at=0.05
***Significant at=0.01

Table 5 shows the descriptive statistics derived from the survey questions, and sorted by case community (with reef quality labeled). Statistically significant predictors of reef quality are indicated with asterisks.

Table 5: Descriptive Statistics from Surveys

Survey Question	Variable Name	Results Lovina (ailing reefs)		Results Pemuteran (healthy reefs)	
Are there clear member versus non-member boundaries	***boundary****	92 %	Yes	56 %	Yes
		8 %	No	44 %	No
Is there a defined hierarchy in the organization?	***hierarch***	94 %	Yes	49 %	Yes
		6%	No	51 %	No
Are the leaders of the reef management organization involved with the day-to-day operations of reef management?	***mgmt*****	98 %	Yes	31 %	Yes
		2 %	No	69 %	No
Do you know who is leading the efforts to manage local reefs?	***member_aware***	88 %	Yes	90 %	Yes
		11 %	No	10 %	No
Is the reef management organization transparent when it makes decisions?	***transpar*****	91 %	Yes	29 %	Yes
		9 %	No	72 %	No
Do leaders of reef management organizations help educate members in order to improve reef management strategies?	***leader_educ***	90 %	Yes	17 %	Yes
		9 %	No	83 %	No
can any member be elected to the reef management organization leadership?	***oppor_elect****	87 %	Yes	46 %	Yes
		13 %	No	54 %	No
Wealthy people are the ones with real power in this community, the reef management organization comes second.	***auton1***	21 %	Agree	84 %	Agree
		79 %	Disagree	15%	Disagree
Hotel owners are the ones with real power in this community, the reef	***auton 2****	32 %	Agree	76 %	Agree

management organization comes second.		67.92%	Disagree	23 %	Disagree

Total Observations: N=112

*Significant at =0.1
**Significant at=0.05
***Significant at=0.01

3.0 Findings

Section 3.0 is a brief summary of the findings of the quantitative results displayed in tables 4 and 5 above. These will be discussed in greater detail in sections 3.1-3.3 with the inclusion of qualitative interview data for explanatory purposes. The statistically significant variables have been grouped into three main categories of findings:

Organizational Boundaries: Requiring all reef tourism practitioners to be members of the institution does not predict healthier reef outcomes, contrary to what was hypothesized. These organizational boundaries have important relationships to ideas on organizational autonomy as their presence impacts the amount of control that elites (wealthy hotel and business owners) have over reef making decisions. More autonomy and independence of the management institution from well-connected elites also did not predict healthier reefs as was hypothesized.

A clearly defined hierarchy: A near universal familiarity with the hierarchy and leadership structure among members did not predict healthier reefs. This meant that high degrees of familiarity with their fellow stakeholders and the institutional inner workings did not predict healthier reefs. Institutional leaders with high degrees of day-to-day involvement in the reef management institution also did not predict healthy reefs, despite the assumption that the primary role of leaders is to help build educational and technical capacity that would result in healthy reefs.

Transparency: Transparent institutions did not predict healthy reefs. These three findings are summarized in table 5 below:

Table 6: Summary of findings & key differences in institutional design

	Organizational Boundaries well defined and the management organizations are autonomously managing the reef	Hierarchies are well defined where people know their leaders, and leaders have high levels of day to day involvement	Reef management decision-making is considered transparent by stakeholders
Lovina (poor reefs)	Yes	Yes	Yes
Pemuteran (healthy reefs)	No	No	No

3.1 Membership Requirements and its relationship to Autonomy

According to similar studies, one of the most important institutional characteristics of successful versus non-successful reef management institutions has to do with the rules that govern membership. These rules specify how membership is

achieved, delineate who is required to have membership, and help avoid a free rider problem within the reef management institution (Cinner et al. 2009 (b), Cinner et al. 2012, Ostrom 2005, Stevenson and Tissot 2014). If membership is mandatory for all reef users, problems of free ridership are solved, and healthier reefs are hypothesized. If membership was optional and criteria to join were vague, reefs of poorer quality were expected. The two cases in this study present an unexpected situation where the hypothesized relationship is reversed, and membership standards are informal in the community with high quality reefs. In Pemuteran, those involved in the reef tourism economy are not all required to be members of the main reef management institution. Membership is instead voluntary and self-selected.

The informal membership rules of Pemuteran's reef management organization reveal several of its unique attributes as a common pool resource management institution. The *Pecelan Laut*, as the institution is named, roughly translating to "sea police" is more of a combined social club, religious group, and esteemed village level cultural phenomenon than it is a common pool resource institution governing a local resource. Stakeholders consistently identified the group as the main reef management organization, but acknowledged that the actual decision-making authority was held by tourism elites, defined here as hotel or resort owners who have invested in at least one high profile conservation effort in the village. TEs are visible figures in the village, well known to all local stakeholders, as their businesses are major sources of local employment. TEs are known in Pemuteran for implementing conservation efforts, funding enforcement, spearheading restoration programs, and behind-the-scenes financial payoffs of village leadership and local politicians that result in conservation.

Stakeholders in Pemuteran's healthy reef system did not perceive their reef management organization to be as autonomous as much of the promotional material would suggest to visitors. Instead, many argued that TEs still have authority over resource management decisions. In the words of one dive industry worker, regarding organizational autonomy:

> It is mostly for show, the idea of a "community-based" organization. At the end of the day, resort owners are in charge. Look at the people who bought hotels here in the 1980s. That is who is really in charge. They have the money, they have to bribe local officials for us, and they bribe the head of the village too. Conditions on the reef are good and tourists come. Their effort isn't bad. These owners are really good people, It's good for us, good for the environment. But it is not what I would call "community-based."

A majority of respondents stated that TEs tend to impact reef conservation decisions through payoffs to local decision-makers, noting that this is somewhat normal in Indonesian governance. Given the end result is the remarkable comeback of Pemuteran's reefs, the lack of autonomy of the local management authority is hard to criticize. Yet some stakeholders worried, saying "eco-conscious resort owners cannot live there forever," casting doubt on the long-term resilience of this regime. Others argued that, although TEs manage reefs in a "behind the scenes" top-down pattern now, increasingly real power would incrementally shift to the Pecelan Laut. When it does shift, their burden will be eased through local and regional mindset-change regarding destructive and illegal fishing, which is showing promising decline. The

community has, in the past decade, seen the economic potential of an ecologically minded tourism approach, including how visitors are willing to pay more to stay in a community with strong stewardship credentials over its reefs. The synergistic effects of eco-tourism in Pemuteran mean that reef conservation is perceived as synonymous with local wealth generation in the minds of villagers. Thus, even if TEs retire and move away, some say the regime will continue as is.

Citing their lack of real decision-making autonomy is not to say that the Pemuteran Pecelan Laut lacks legitimacy or village-wide admiration. The Pecelan Laut is a source of great pride for many stakeholders. Its members tend to be highly respected, relatively prosperous young men who "had a place for the reef in their hearts" as one member put it. Members typically congregate in traditional dress at the beachfront office (See Figure 4), where they encourage tourists to visit, make donations, ask questions, and buy souvenirs. These villagers are there to make the socio-economic links between village life and reef health apparent to visitors, even when real management authority and capacity is quite limited.

For example, one stakeholder remarked that the Pecelan Laut perform monitoring patrols every Saturday and Sunday to ensure the safety of the reef. He then quipped, "If the bad guys know you are coming, they will not be poaching on Saturday and Sunday. They will poach on Monday." Others echoed a similar sentiment, suggesting that the real purpose of the Pecelan Laut was to drink coffee and smoke cigarettes on the beach. Most importantly, Pemuteran's healthy reefs and its global reputation for sustainable development would suggest that the Pecelan Laut's self perceptions as autonomous leaders in reef management may matter more than actual autonomy over decision making around the reef. These self perceptions combined with their elite status in the community are possibly more significant than veritable decision-making autonomy in common pool resource management.

Figure 4: Pecelan Laut in their shorefront office in Pemuteran

Despite its ailing reefs, Lovina's reef management organizations have mandatory membership for anyone operating a boat for reef tourism purposes. Members pay required monthly dues in the form of a percentage of earnings, and readily acknowledge that this is to avoid free riders benefiting from their hard work protecting the reefs. This demonstrates local understanding of the ideas behind common pool resource management theory. Stakeholders use dues for insurance and for infrastructure upgrades such as mooring buoy replacements on local snorkel and dive spots. Members exhibited a large degree of familiarity with one another.

Interviews suggested universal membership requirements and strong interpersonal relationships caused strong buy-in in the local management institutions. It also allowed stakeholders to create what they perceived as a fair, limited, and organized access system to the reef, called *antrean* in Balinese. This system ensured that that all of the village's boats would not be on the reef or performing marine mammal tours simultaneously, and instead, a rigid turn-taking system was in place so as not to overcrowd. This ensured not only that boat captains would not steal one another's business, but also that tourists would not feel as if locals overcrowded the reefs. Graduated sanctions are in place to ensure rule breaking did not occur, and similar studies have shown these to be very effective (Wamukota et al. 2012). Respondents recalled times they had experienced sanctions as experiences they did not want to repeat. Labeled *scorcing* these sanctions would include several weeks where their engine would be confiscated by the management institution to prevent them from

making trips to the reefs with tourists. The threat of scorcing was considered such an immense blow to their income, that high levels of inter-personal trust were evident. In other words, scorcing was so severe that stakeholders trusted their peers were following the rules.

3.2 Leadership, Hierarchy, and Capacity Building

Similar studies have demonstrated a link between healthy ecological outcomes, co-managed institutions, and well-defined leadership within the institution (Pomeroy 1995). This study finds that a formalized and well-known hierarchy within reef management institutions does not necessarily predict healthier reefs, contrary to what was hypothesized. In Pemuteran, leadership within the Pecelan Laut was a respected position, somewhat ceremonial position, awarded to a highly respected member of the community who played a role in blocking poachers in the village's early days. Yet, many stakeholders, despite citing the Pecelan as the main reef management institution, did not recognize their leader as one of the main reef management leaders. Many instead cited the owners of local resorts as such leaders along with other TEs. The difference between what was hypothesized and what was observed means that democratically elected leaders are not always predictors of healthier reefs in all cases. Leaders with strong local clout and a history of reef conservation advocacy, like Pemuteran's TEs, are equally important in forming successful institutions.

Lovina on the other hand had stakeholders who nearly unanimously named a single organizational leader, and the leaders of organizations in the other villages that constitute Lovina. Furthermore, every member of the organization is expected and encouraged to lead the organization at one point in his career. Heads of reef management institutions in four of Lovina's six villages unanimously touted this opportunity for leadership as a source of legitimacy among members, saying that ultimately serving in this capacity means you have all the more reason to respect the current leadership. Respondents argued that transparency, trust, and pervasive feelings of ownership among stakeholders were linked to the possibility that they too could be the leader one day.

Figures 6 and 7: Lovina Reef Management Stakeholders next to their vessels

Lovina has a large degree of day-to-day involvement of its reef management leaders. This increases organizational capacity, as a large amount of these day-to-day duties involve training and education efforts. Thus, Lovina possesses the capacity to coordinate a well-financed and innovative effort at conservation similar to those used to restore the reefs of Pemuteran. In Pemuteran's early days of development, the TEs brought large amounts of financial capital to Pemuteran in order to invest in restoring the reefs shortly after the Indonesian government banned destructive fishing in the late 1980s. They invested in innovative mineral accretion technology to restore the reef at a

rapid rate using electrical charge, and then marketed this technology as a tourist attraction. Well-connected leaders seeking to finance these types of efforts are not present in Lovina, with the capital levels required for upfront investment presently unavailable. Similar investments to those made in Pemuteran's early days could meet comparable results in Lovina because of the large degree of organizational capacity evidenced in its participatory, collaborative institutions already in place.

Two caveats exist however relating to innovative technology based coral restoration technology. The first is that its drawbacks include the need for living corals to be harvested in order to "seed" growth on the charged lines. Many stakeholders in Pemuteran, especially those working in dive shops not affiliated with this technology, said that despite attracting awards, accolades, and visitors, they were skeptical of mineral accretion technology's true restorative capacities. Many said they view the technology as an attraction geared towards eco-tourists that, unbeknownst to them, causes living stands of branching coral to be extracted from the healthy reefs.

Those on the other side of the debate say that despite harvesting living coral, more coral is grown and ultimately "replanted" on the reefs. More importantly, supporters argue that these efforts are only partially inspired by best reef restoration practice, and the real reason is to change local mindsets around reef stewardship in order to make it intrinsic to Pemuteran's way of life. The second caveat is that reef survival is intrinsically linked to land use land planning decisions made on property adjacent to the reefs. Poor land use planning results in sediment runoff that inhibits coral growth and survival. In the past ten years, many of the buyers of beachfront hotels in Lovina have been Western Europeans who do not relocate to Lovina and instead own the investment property remotely. The Pemuteran model is quite different, and includes a history of Australian, English, and Indonesian TEs investing in conservation efforts and acting as local conservation champions over a period of decades. This cannot be so easily replicated in Lovina under these land use and development conditions.

3.3 Transparency

Greater transparency in decision-making was hypothesized to occur in communities with healthier reefs. Surprisingly, this study found that transparent management decision-making was present in Lovina, but somewhat absent in Pemuteran. Similar studies highlight the importance of transparency in common pool resource management (Cinner et al. 2009 (b), Berkes 2011, Ostrom 2005, Stevenson and Tissot 2014, Wamukota et al 2012), but tend to focus on transparency and accountability for rule enforcement relating to rules that govern access to the resource. This study conceptualizes accountability somewhat differently: how well stakeholders can map the act of decision-making and the subsequent process of implementation. In other words, if members want some aspect of reef management changed, can they raise the issue within the institution, vote on it, and see it implemented? Can they trace management issues from the point where they enter the agenda to implementation? The alternative model is one where reef management decisions are made and imposed from the top down.

In Lovina, despite poor quality reefs, stakeholders can universally outline the process for making and implementing policy changes to the reef management regime. They outlined a process where a monthly meeting was held, issues could be raised by any member, voted upon, and then enacted using funds created by membership dues. Pemuteran on the other hand saw some stakeholders able to describe the decision-making process, and others unable to do so. Even some elite dive business owners could not describe how decisions were made and policies were implemented. Some attributed decision-making and implementation to TEs, and others to the Pecelan Laut. Transparency therefore is not a firm predictor of reefs when defined in this way, and should be conceptualized more broadly other studies on reef management.

Another notable difference related to transparency was observed in the way that villages promoted and marketed their efforts to manage local reefs to visitors and tourists. This has not yet been discussed in co-management management literature on coral reefs. Pemuteran publicizes its reef management institution and its local reef-focused NGOs to its visitors, which was repeatedly observed to resonate positively with tourists, and has been shown repeatedly to win conservation awards at national and international levels. It is mainly the Pecelan Laut who emphasize and communicate the community-oriented aspects of their reef management organization. This is not the case in Lovina as there is no mention of its community-based management in any form to visitors. The office is difficult to find, marked in Balinese, and with limited hours of operation. There is a large sign advertising Lovina's reef organizations centrally located on the village beach, however it is also written exclusively in in Balinese. The behind-the-scenes work that Lovina's villagers put into their management institution is largely invisible to tourists, along with their group-wide efforts at managing reefs for ecosystem health and their remarkable knowledge of the ecosystem. Typically, to speak with a reef management leader, one would need to find them at home in residential areas where tourists tend to not visit.

Figure 8: Advertisement in Balinese for the local management institution

Since stakeholders in Lovina do not publicize their complex, democratic reef management organizations to their visitors, they effectively forgo a value added benefit from a type of en vogue ecotourism, where increasingly visitors are concerned with the ethics behind their Southeast Asian eco-tourism experience (Mustika et al. 2003). One Lovina reef management leader displayed a photo in his home where he was receiving an award on behalf of the local organization from former Indonesian Prime Minister Megawati Sukarnoputri, an important environmental accolade that was not made visible to visitors. As a result, there was an observably greater adversarial relationship between Lovina's tourists compared to Pemuteran's. Lovina tourists were looking for the lowest prices, and villagers looking to fill up their boats for snorkel tours. This means that tourists are not visiting reefs with full knowledge of the socio-economic links between Lovina's village life and the local reefs. They are not willing to pay more to ensure that locals have incentives to keep reefs healthy, as they are willing to do in Pemuteran where the village-reefs-livelihoods link is made explicit to tourists. There were many observed instances where a notable difference in Western tourists' willingness to accept higher fares occurred when they knew villagers are working collectively towards reef sustainability. Interviews with tourists nearly unanimously suggested that if they had known of the effort in Lovina, they would have donated to their reef management institution. Lovina's local organizations are truly autonomous and in the hands of the community, yet they have not received the types of acclaim, awards, and recognition by multilateral institutions that Pemuteran does. This could be due to the fact that its reefs remain degraded, and that the need to market this kind of socioeconomic relationship to the ecological system is not well known.

This additional income could be useful to Lovina reef stakeholders who nearly unanimously lamented the uncertainty that characterizes their lives based on reef tourism. The most significant source of uncertainty in Lovina is the persistent low income of reef tourism stakeholders. Given increasing regional fuel prices, unwieldy impacts of stochastic events on the tourist economy such as large storms, and the impending havoc of climate change and warming oceans, this uncertainty will not diminish in the near future. If Lovina were to publicize its community-based efforts to manage its reefs democratically and to be more transparent about the planning it does around reef management, the community could attract greater revenue. This could be used for enhancing critical infrastructure, such as mooring points on reefs. It could also be used to implement technological fixes that quicken the pace of coral recovery.

Differing development trajectories toward a tourism-based economy also played an important role, according to stakeholder perceptions, on whether reefs improved or remained degraded. A key piece of Pemuteran's development trajectory was shaped by top down decision making over conservation that resulted in the healthy reef outcomes today. In the 1980s, when regional reef recovery and tourism first began, a small number of respected TEs in Pemuteran collaboratively devised a development strategy. Their vision focused on deliberate, slow growth that framed Pemuteran as a diver's paradise for those with an ecological conscience in need of an off-the-grid excursion. Growth occurred very differently in Lovina. Beginning in the 1980s, published travel guides described Lovina's villages as "paradise," located off the beaten tourist path. The result was a dramatic increase in tourism that occurred, according to many stakeholders, "over night." Hotel and facility construction was unable to keep pace with its influx of tourists. More accessible connections to the major tourist cities in the south of Bali meant that a simple trip connected busloads of tourists to Lovina's well-marketed black sand beaches and dolphin tours. Whereas there are hourly shuttles to and from Lovina from Bali's main tourist cities, travel to Pemuteran requires improvisation. One informant stated a possible cause in the difference between reef systems is due to the "travel guide book phenomenon" where Lovina, in its early days, received many mentions in travel guides while Pemuteran did not. A few TEs said that they asked editors of such guides to keep them out on purpose, saying they did not want to become the next Lovina.

With a much slower transition into tourism, and a slow payoff, one would expect Pemuteran's villagers to experience difficulty linking reef health and increasing revenue (McClanahan and Davies 2005). While the link between the healthy ecosystem and the healthy economy slowly became evident, covert violations of no-take rules, destructive anchoring bans, and destructive methods fell rapidly. Increasing numbers of locals began to work in the tourism industry, leaving behind fishing. Conservation became a social norm. This transition was possible because locals were buttressed by well-financed TEs, who were able to pay off village leaders, community groups, fishermen, and politicians to make them more amenable to reef conservation. TEs reported buying the fishers out, paying them a lump sum to no longer fish the reef. Thus, the early days of Pemuteran resembled an informal, locally financed "payments for ecosystem services" scheme (Engel et al. 2008). TEs provided the payments, in a legal manner or

otherwise, to people who could prevent reef degradation. Most importantly, they also provided jobs and actively encouraged those with livelihoods that threatened the reef to transition into tourism. Wages rose, and more people were employed through time as Pemuteran grew. These same TEs began to form several local environmental NGOs responsible for restoring the reef, these include BioRock, Reef Gardeners, and the Turtle Project.

This de-facto payment for environmental services scheme, increased employment, and increased environmental consciousness, allowing one-time extractive reef users to transition into the tourism economy. Thus, the contemporary need for a management institution dedicated to enforcement is less pronounced. One TE mentioned how in the 1980s, his resort was nearly razed to the ground by a dozen fishermen intending to poach the reef using cyanide. He drove them off through threats of force, and by phoning his friends in the Indonesian army. He and others claimed that information about these types of events traveled by word of mouth, albeit slowly, and Pemuteran gained gradually reputation as a reef where poachers would not be tolerated. In the words of another TE:

> It was slow work, it takes time. If Lovina had taken more time, they would look more like us [in Pemuteran]. There were tourists snorkeling, trampling, and fishing their reef when we were rebuilding ours from tatters. Literally fighting poachers off of it. For decades Government wasn't here. Village leadership was moderately dependable, when you paid them off. We chased them off through hard, hard work. I can't say I'd have it in me to do it again.

4. Discussion

The findings above both support and contradict several key studies on co-managed reefs. Cinner and Huchery 2014 examine 42 case sites in a comparative fashion spanning Kenya, Tanzania, Papua New Guinea, and Indonesia. Their analysis looks at the relation between social outcomes (livelihood satisfaction and compliance) and the number of rules, the makeup of the rules, and the specific type of co-management framework (whether the case is a national park, traditionally managed, or locally-managed MPA). They found that stakeholders in traditionally managed systems, and local co-managed systems tended to see great benefit to their own livelihoods in the sustainable management of local reefs, while stakeholders in devolved, locally managed frameworks did not share this perception. Views of the Lovina stakeholders in this study conflict with these results however. Lovina stakeholders, despite their locally-initiated, devolved, co-managed framework without any outside NGO presence still viewed the efforts of the community based reef management institution as having direct positive impacts on their livelihoods. This study's findings in Pemuteran supported the findings of Cinner and Huchery 2014, as this village presents a case of locally developed protected areas, in conjunction with civil society and government partners. Stakeholders there also, as predicted, viewed the efforts of the management institution as beneficial for local livelihoods.

A similar study on co-managed reefs in Raja Ampat, Indonesia (Dirhamsyah 2013) suggests that NGOs are a critical ingredient for success, in addition to government support across scales, and local political will. There is evidence for this idea in this study, since Pemuteran had assistance from several NGOs, critical in grant

writing and applying for various awards. Notoriety, outside financing, and capacity building were noticeably missing in the Lovina case, where there were no NGOs present to assist the local management institutions. It is very important to note however that in many instances in Pemuteran, where there was a strong NGO presence, certain stakeholders heavily criticized the NGO activities as interference. Mulrennan et al. 2012 has summarized some of these complaints in their study: [NGOs care more about the] "response to the demands of donor and other external agents, [and] fundamental principles of social justice and community empowerment were sidelined in favour of externally determined conservation agendas (see Chapin 2004 for examples)." Even some TEs criticized the efforts of certain NGOs as striving for awards and recognition, while other NGOs were working hard on day-to-day management (such as crown of thorns removal).

Similarly, Berkes 2011 Draws a distinction between community based management that develops spontaneously in the community, and management that develops at the behest of outsiders, friendly and helpful as they may be to the socio-ecological systems. Many of the TEs in this study were outsiders who spent decades living, working, and investing in sustainable social, economic, and ecological outcomes of Pemuteran's reef system. That said, should their contributions to healthy reef outcomes be questioned because they were not born into the village itself? Are the non-Indonesian TEs different from Indonesian TEs when conceptualizing the community despite comparable time and financial investment in local conservation? These are the complicated questions that institutional analysis helps side step, by re-directing the focus of the analysis to institutional makeup. But these questions still remain. In this study, many of Pemuteran's stakeholders were overwhelmingly grateful to TEs, and many were also very critical of their real intentions. These criticisms often focused on whether TEs were winning awards at the expense of engaging in day-to-day conservation work.

This study did not test for certain variables effects on reef health that have been shown in other similar studies to not be statistically significant. These include: multiple income levels in the villages, involvement in decision-making, mean years of education, and proportion of the community in alternative occupations such as farming (McClanahan et al 2006). Other studies have shown that frequent reminders of the benefits of conservation tend to promote collective action around conserving the reef (McClanahan et al. 2006). In the case of Pemuteran, this can be evidenced in the frequencies of awards and recognition this community has received since the early 90s, and thus the findings in this study support the importance of the need for continuing social cues that remind stakeholders of the benefits of conservation.

In a similar study (Cinner et al. 2009 (b)) examines and compares reef management institutions in Kenya and Madagascar. Their design and theorized institutional components are similar to the ones used in this study. They make a notable point regarding a potential criticism for this kind of research: comparative research on institutional components may lead to a one size fits all or blue-print interpretation of results. In other words, practitioners and communities may read studies like these and then try and impose institutions on communities based on the findings presented here

and in similar studies. The findings in this study support this argument made by Cinner et al. 2009. A major takeaway from the findings presented here is that certain theorized components of successful management institutions may not always predict reef quality. Thus, a heterogeneous view of reef institutional design is necessary depending on the livelihood needs and development trajectories of individual communities.

5.0 Conclusion

Successful reef management is a product of institutions combined with development trajectory, local livelihood concerns, and communication of local efforts to visitors. Much of Pemuteran's remarkable reef recovery is due to its early, innovative, ad hoc payments for ecosystem service programs. The critical difference between these communities is the up-front capital that has allowed Pemuteran to rapidly regenerate much of its reef building coral through innovative technology. Community members who hold the respect of villagers have a large degree of influence on reef management, whether or not they are elected to a management organization. Perhaps the democratically elected leaders of Lovina's cooperatives can harness their legitimacy in order to gain the funding and capacity to create payment for ecosystem services schemes in their villages, that fit local needs. They have already established organized, democratic, legitimate cooperatives. The next step would be acquiring funding to replicate Pemuteran's success.

Several institutional attributes that are commonly linked to healthy ecosystems were found in this study to not predict reef health. These include: requirement of all reef stakeholders to have membership in the institution, institution-wide familiarity with leaders, day-to-day involvement of leaders in management, and transparent decision-making and implementation. These findings are not the major takeaway however; instead it is that there are no one-size fits all models for reef management institutions. Instead, individual communities must collaboratively manage their resources in ways that fit their own unique relationships to the tourists who visit their reefs, their relationships between fellow reef stakeholders, and that community's particular economic development history.

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